basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Consider the statement below.

The perpendicular force exerted by a surface on an object in contact with the surface.

Which ONE of the following forces is defined by the statement above?

A Normal force

B Resultant force

C Frictional force

D Gravitational force (2)

1.2 Two balls of masses m and 2m are dropped simultaneously from the same height above the ground. Ignore air resistance.

When the balls strike the ground, which ONE of the following physical quantities will be the same for both balls?

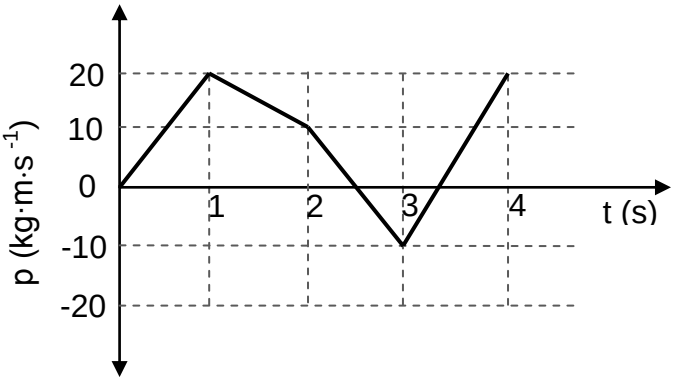
A Weight

B Velocity

C Momentum

D Kinetic energy (2)

1.3 The graph below shows how the momentum (p) of an object changes with time (t).



During which ONE of the following time intervals, measured in seconds, is the magnitude of the net force acting on the object the greatest?

A 0 to 1

B 1 to 2

C 2 to 3

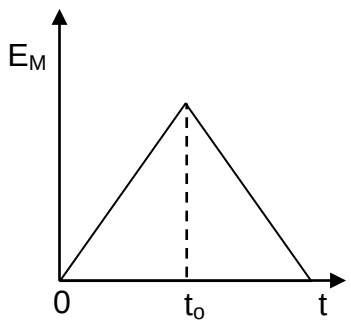
D 3 to 4 (2)

1.4 A ball is dropped from a height above a floor. The ball makes an elastic collision with the floor at time t_o and bounces vertically upwards.

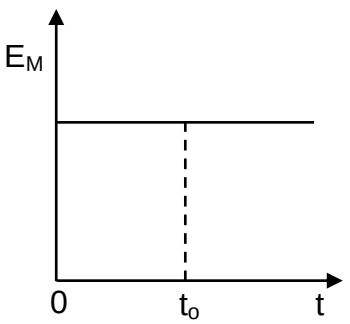
Ignore air resistance.

Which ONE of the following graphs shows how the total mechanical energy (E_M) of the ball changes with time?

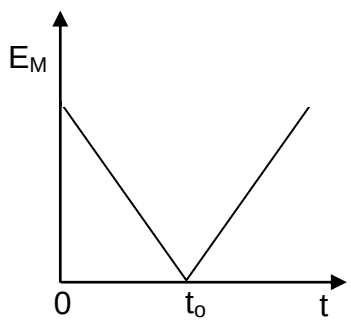
A



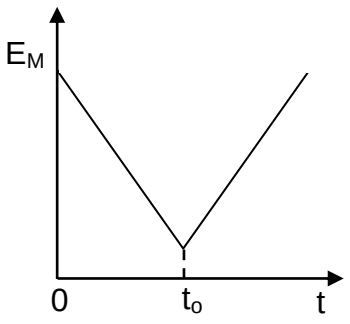
B



C



D



(2)

1.5 Consider the two spectrum diagrams below.

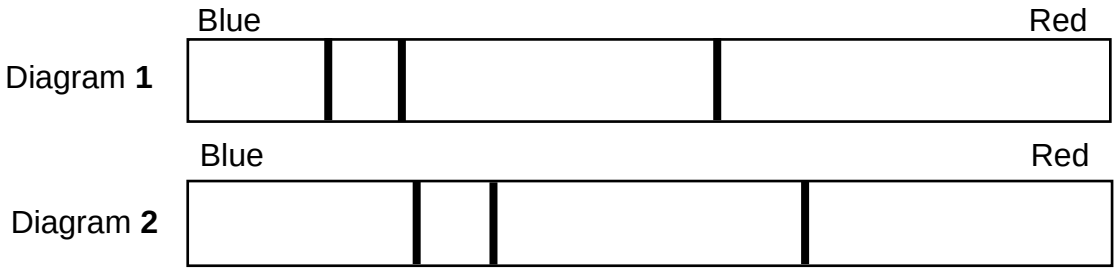


Diagram **1** represents the spectrum of an element in a laboratory on Earth.

Diagram **2** represents the spectrum of the same element from a distant star as observed from Earth.

Which ONE of the following can be deduced from the spectra above?

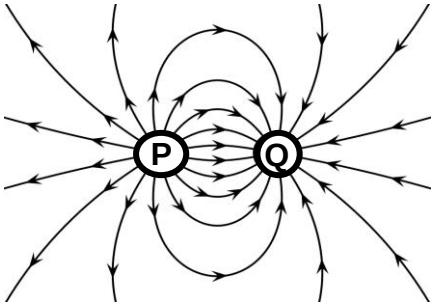
A The star is moving towards Earth.

B The star is at rest relative to Earth.

C The star is moving away from Earth.

D Both the star and Earth are moving towards each other. (2)

1.6 The diagram below shows the field lines for the combined electric field due to two small charged spheres **P** and **Q**.



Which ONE of the combinations below correctly shows the polarity of spheres **P** and **Q**?

	SPHERE P	**SPHERE Q**
A	Negative	Positive
B	Negative	Negative
C	Positive	Positive
D	Positive	Negative

(2)

1.7 Two identical spheres, **P** and **Q**, carry charges of +q and –2q respectively. Sphere **P** exerts an electrostatic force of magnitude F on sphere **Q**.

Which ONE of the following represents the magnitude of the electrostatic force exerted on sphere **P** by sphere **Q**?

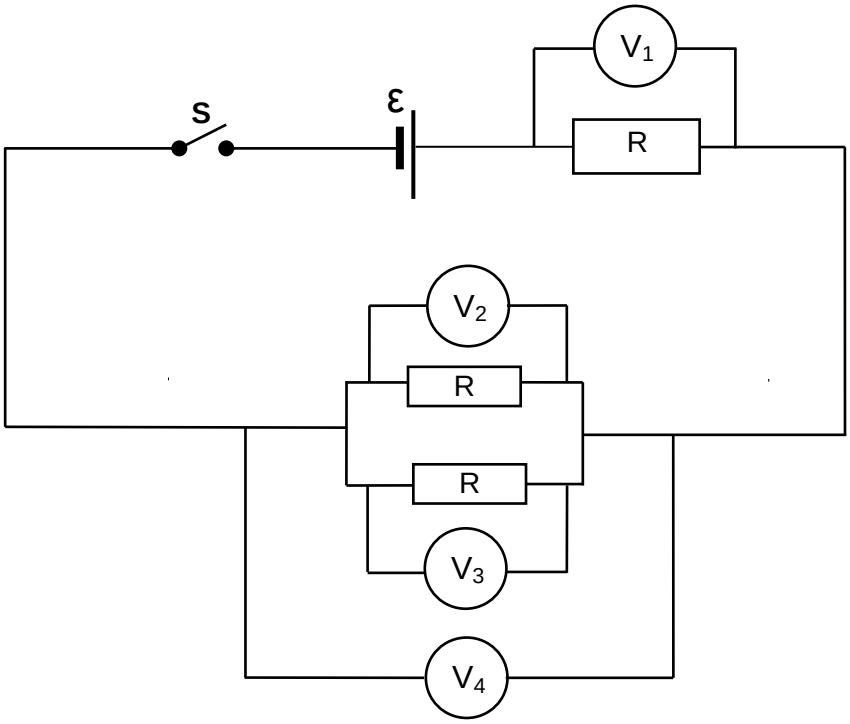
A $\frac{1}{2}$F

B F

C 2F

D 4F (2)

1.8 In the circuit diagram shown below all the resistors are IDENTICAL. Ignore the internal resistance of the cell.



Which voltmeter will have the HIGHEST reading when switch **S** is closed?

A V_1

B V_2

C V_3

D V_4 (2)

1.9 In which ONE of the following electrical machines is electrical energy converted to mechanical energy?

A AC generator

B DC generator

C AC dynamo

D DC motor (2)

1.10 Which ONE of the following combinations correctly links an emission spectrum and an absorption spectrum to the energy transitions of an electron in an atom?

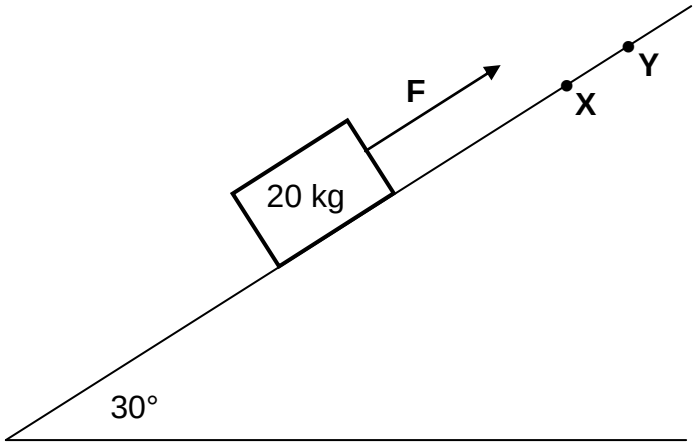
	EMISSION SPECTRUM	**ABSORPTION SPECTRUM**
A	From low to high energy levels	From high to low energy levels
B	From low to high energy levels	From low to high energy levels
C	From high to low energy levels	From high to low energy levels
D	From high to low energy levels	From low to high energy levels

(2)
[20]

QUESTION 2 (Start on a new page.)

A 20 kg block is placed on a rough surface inclined at 30° to the horizontal. A constant force **F**, acting parallel to the surface, is applied on the block so that the block moves up the incline at a CONSTANT VELOCITY of 2 $m \cdot s^{-1}$. Refer to the diagram below.

A constant kinetic frictional force of 18 N acts on the block.



2.1 State *Newton's First Law* in words. (2)

2.2 Draw a labelled free-body diagram for the block. (4)

2.3 Calculate the magnitude of force **F**. (4)

Force **F** is removed when the block reaches point **X** on the surface. The block continues to move up the surface and comes to rest momentarily at point **Y**.

Assume that the kinetic frictional force acting on the block remains at 18 N as it moves from point **X** to point **Y**.

2.4 Write down the net force acting on the block as it moves from **X** to **Y**. (2)

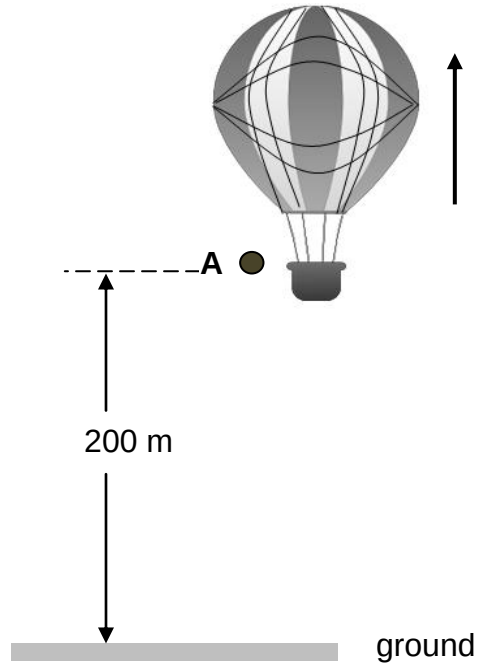
2.5 Calculate the distance between points **X** and **Y**. (4)
[16]

QUESTION 3 (Start on a new page.)

A hot-air balloon is moving upwards at a CONSTANT UNKNOWN speed.

3.1 Is the hot air balloon in free fall? Choose from YES or NO.

Give a reason for the answer. (2)



When the balloon is 200 m above the ground, a small stone **A** is dropped from the balloon. See the diagram above. Another small stone **B** is dropped 5 s later from the balloon while the balloon is still moving upwards at constant velocity.

Stone **A** strikes the ground at a speed of 62,68 $m \cdot s^{-1}$.

Ignore air resistance.

3.2 Calculate the:

3.2.1 Speed of the hot air balloon (3)

3.2.2 Time it takes stone **A** to strike the ground (3)

3.2.3 Distance between the hot-air balloon and stone **B** at the instant when stone **A** strikes the ground (6)

3.3 On the same set of axes, draw position-time graphs for both the hot-air balloon and stone **A** from the moment the stone is dropped until it strikes the ground.

Use the ground as zero reference.

Label your graphs **BALLOON** and **A**. (4)

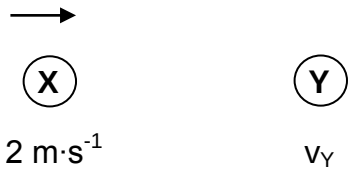
[18]

QUESTION 4 (Start on a new page.)

A ball **X**, of mass 10 kg, is moving eastwards with a velocity of 2 $m \cdot s^{-1}$. It collides ELASTICALLY with another ball, **Y**, of mass 2 kg which was moving with an unknown velocity v_Y (Diagram **A)**. Immediately after the collision, ball **X** comes to rest and ball **Y** moves eastwards with a kinetic energy of 36 J (Diagram **B**).

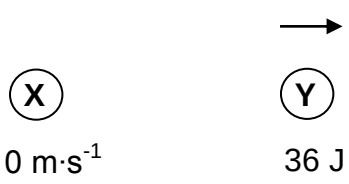
Ignore friction.

DIAGRAM A

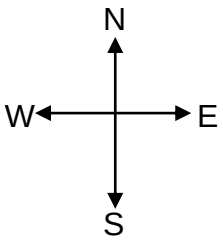


Before collision

DIAGRAM B



After collision



4.1 Explain the meaning of the term *elastic collision*. (2)

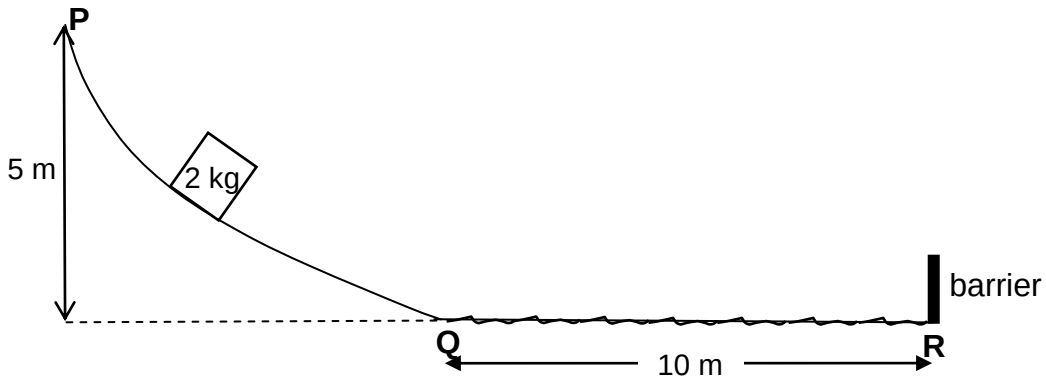
4.2 Calculate velocity v_Y. (5)

The balls were in contact with each other for 0,1 s during the collision.

4.3 Calculate the magnitude of the force that ball **X** exerted on ball **Y** during the collision. (3)
[10]

QUESTION 5 (Start on a new page.)

A 2 kg box is released from rest at point **P**, 5 m above the ground. It slides down a smooth frictionless curved track **PQ**. See the diagram below.



5.1 State the *principle of conservation of mechanical energy* in words. (2)

5.2 Use the PRINCIPLE OF CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the box when it reaches point **Q**. (3)

The box passes point **Q** and moves 10 m on a rough horizontal surface before striking a barrier at point **R** at a speed of 4 $m \cdot s^{-1}$.

5.3 Use ENERGY PRINCIPLES to calculate the magnitude of the average frictional force acting on the box as it moves from **Q** to **R**. (4)

The barrier exerts an impulse of 14 N·s to the LEFT on the box when the box strikes the barrier.

5.4 Calculate the change in kinetic energy of the box after striking the barrier. (5)
[14]

QUESTION 6 (Start on a new page.)

The siren of a stationary ambulance emits sound waves at a constant frequency of 680 Hz. A man is standing with a detector that records the wavelength of the sound emitted by the siren, as shown in the diagram below.

The speed of sound in air is 340 $m \cdot s^{-1}$.

6.1 Calculate the wavelength of the detected sound. (3)

The ambulance now moves at a constant speed along the road TOWARDS the man. The detector now records the wavelength of the sound, which differs from the previous reading by 0,05 m.

6.2 State the Doppler effect. (2)

6.3 How would EACH of the following have changed when the ambulance approached the detector compared to when the ambulance was stationary?

Choose from INCREASED, DECREASED or NO CHANGE.

6.3.1 Distance between the wave fronts (1)

6.3.2 Frequency of the detected waves (1)

6.4 Calculate the speed of the ambulance. (5)
[12]

QUESTION 7 (Start on a new page.)

7.1 A small neutral sphere acquires a charge of -1,95 x 10^{-6} C.

7.1.1 Were electrons ADDED TO or REMOVED FROM the sphere? (1)

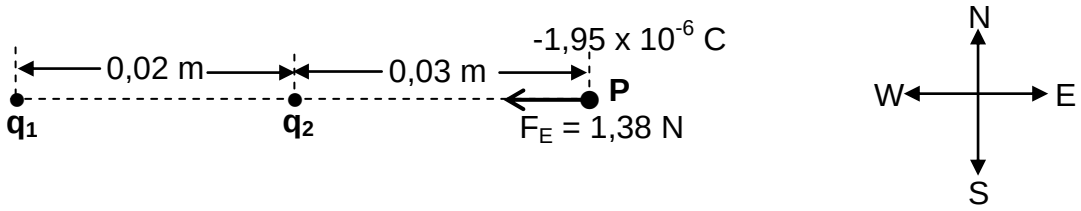
7.1.2 Calculate the number of electrons which were added or removed. (3)

7.1.3 Define the term *electric field at a point*. (2)

7.1.4 Calculate the magnitude of the electric field at a point 0,5 m from the centre of the charged sphere. (3)

7.2 Two point charges, $\mathbf{q_1}$ and $\mathbf{q_2}$, are fixed 0,02 m apart. The magnitude of charges $\mathbf{q_1}$ and $\mathbf{q_2}$ is the same and $\mathbf{q_1}$ is NEGATIVELY charged.

The small charged sphere with the charge of -1,95 x 10^{-6} C is placed at point **P**, 0,03 m east of charge $\mathbf{q_2}$, as shown in the diagram below. The sphere at point **P** experiences a net electrostatic force of 1,38 N west.

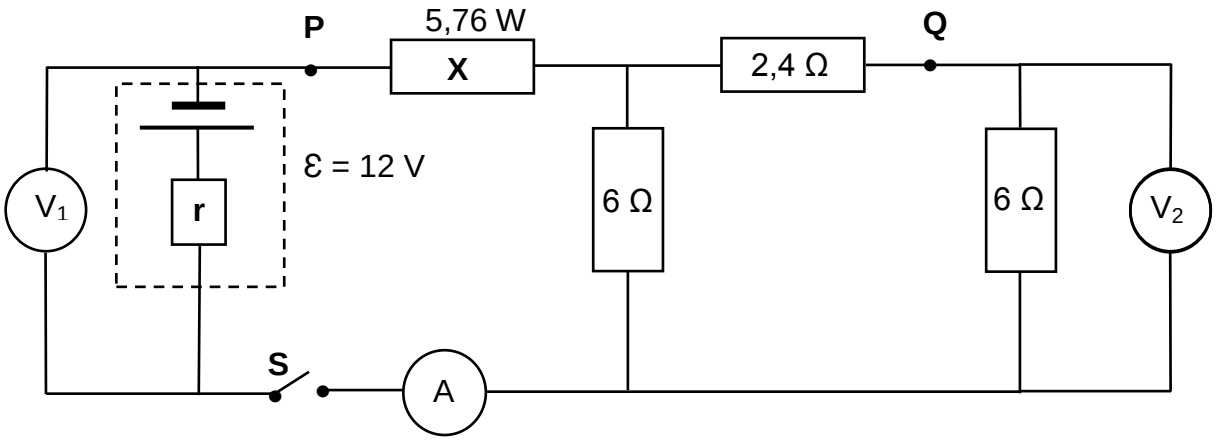


Calculate the magnitude of the charge on $\mathbf{q_2}$. (5)
[14]

QUESTION 8 (Start on a new page.)

The battery in the circuit shown below has an emf of 12 V and an unknown internal resistance **r**.

The resistance of the connecting wires and the ammeter is negligible.



Switch **S** is OPEN.

8.1 Write down the reading on:

8.1.1 Voltmeter V_1 (1)

8.1.2 Voltmeter V_2 (1)

Switch **S** is now CLOSED.

The reading on the ammeter is 1,2 A and the power dissipated in resistor **X** is 5,76 W.

8.2 Define the term *power.* (2)

Calculate the:

8.3 Resistance of resistor **X** (3)

8.4 Total EXTERNAL resistance of the circuit (3)

8.5 Reading on voltmeter V_2 (5)

A length of wire of negligible resistance is used to connect point **P** to point **Q** in the circuit.

8.6 How will the reading on voltmeter V_1 be affected?

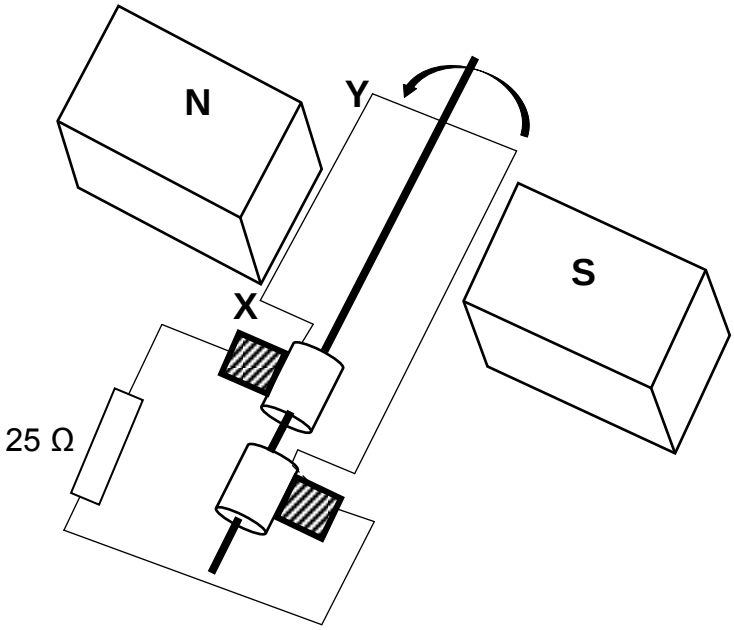
Choose from INCREASES, DECREASES or NO EFFECT.

Explain the answer. (4)

[19]

QUESTION 9 (Start on a new page.)

A simplified diagram of an AC generator connected to a 25 Ω resistor is shown below. The coil rotates anticlockwise.

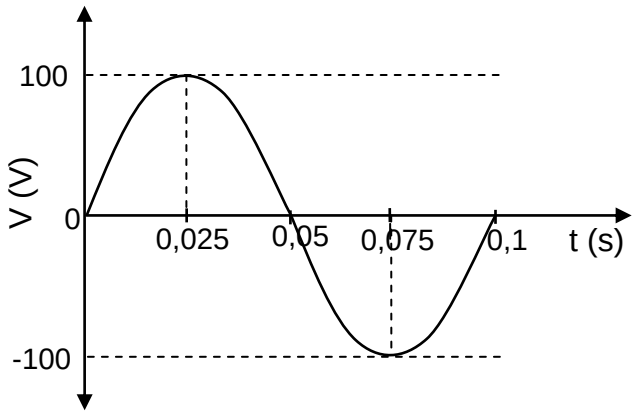


9.1 Name the component that distinguishes this generator from a DC generator. (1)

9.2 In which direction will the induced current flow in section **XY** of the coil?

Choose from **X to Y** OR **Y to X**. (2)

The graph below shows the output voltage of the generator for one cycle of rotation of the coil.



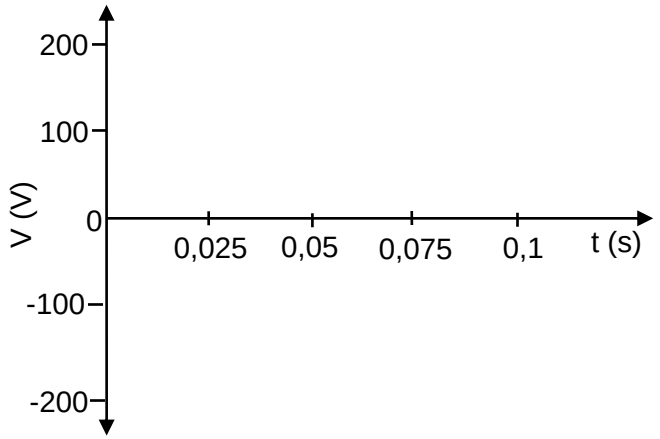
9.3 Define the term *rms potential difference*. (2)

9.4 Calculate the rms current in the circuit. (4)

9.5 Calculate the average power dissipated in the 25 Ω resistor. (3)

The speed of rotation of the coil in the generator is now DOUBLED.

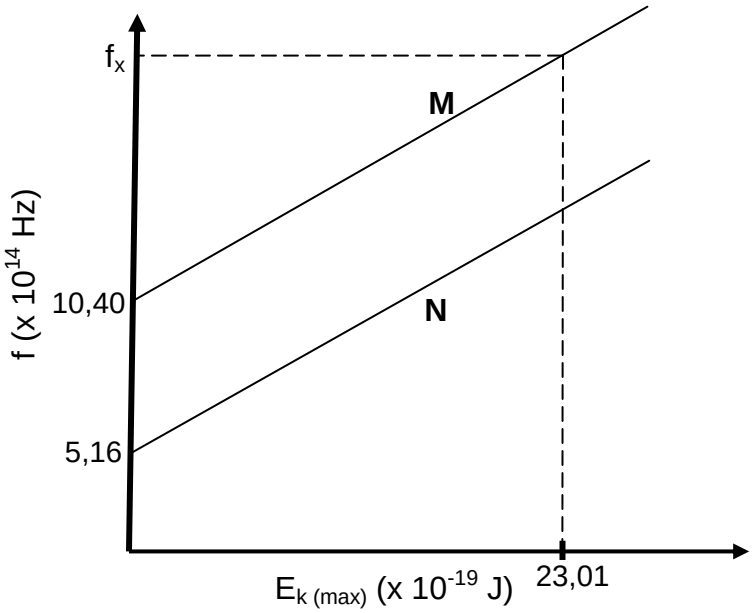
9.6 Copy the set of axes below in your ANSWER BOOK and sketch the graph of output voltage versus time for 0,1 s.



(3)
[15]

QUESTION 10 (Start on a new page.)

The relationship between frequency (f) and maximum kinetic energy ($E_{k(max)}$) of photoelectrons emitted from two cathodes, **M** and **N**, of different photoelectric cells is investigated. The graphs below have been obtained from the results.



10.1 Define the term *threshold frequency*. (2)

10.2 How does the maximum kinetic energy of photoelectrons emitted from cathode **N** compare to the maximum kinetic energy of those emitted from cathode **M** when light of a frequency greater than 10,40 x 10^{14} Hz is shone on each of the cathodes?

Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (2)

10.3 Calculate the value of frequency f_x indicated on the graph. (5)

10.4 The experiment is now repeated for cathode **M** using light of frequency f_x, but of higher intensity. How will EACH of the following be affected?

Choose from INCREASES, DECREASES or NO EFFECT.

10.4.1 The y-intercept of the graph (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

10.4.3 The maximum kinetic energy of the emitted photoelectrons (1)

[12]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24}\ kg$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\ 2} = v_i^{\ 2} + 2a\Delta x$ or/*of* $v_f^{\ 2} = v_i^{\ 2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /*of* $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max)}$ or $E = W_0 + K_{max}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(max)} = \frac{1}{2}mv_{max}^2$ / $K_{max} = \frac{1}{2}mv_{max}^2$	
$E = W_0 + E_{k(maks)}$ *of* $E = W_0 + K_{maks}$ *waar* $E = hf$ *en* $W_0 = hf_0$ *en* $E_{k(maks)} = \frac{1}{2}mv_{maks}^2$ / $K_{maks} = \frac{1}{2}mv_{maks}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = I(R + r) emk (ε) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ $P_{ave} = I_{rms}^2R$ / $P_{gemiddeld} = I_{wgk}^2R$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{ave} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2021

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

This marking guidelines consists of 26 pages.
Hierdie nasienriglyne bestaan uit 26 bladsye.

QUESTION 1/*VRAAG 1*

1.1 A ✓✓ (2)

1.2 B ✓✓ (2)

1.3 D ✓✓ (2)

1.4 B ✓✓ (2)

1.5 C ✓✓ (2)

1.6 D ✓✓ (2)

1.7 B or/*of* F✓✓ (2)

1.8 A or/*of* V_1✓✓ (2)

1.9 D ✓✓ (2)

1.10 D ✓✓ (2)

[20]

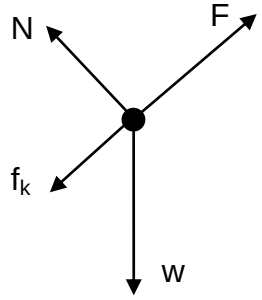
QUESTION 2/*VRAAG 2*

2.1

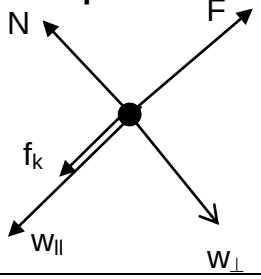
Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. /*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force/unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.
OR/*OF*
A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net /unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto/ongebalanseerde krag daarop inwerk. (2)

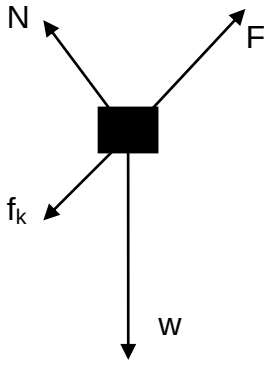
2.2



Accept/Aan*vaar*



Accept force diagram/
Aanvaar kragtediagram



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg /196 N / gravitational force *F_g / F_w / gewig / mg / 196 N / gravitasiekrag*
F	F_A / Applied force *F_T / Toegepaste krag*
f_k	(kinetic) Friction /*(kineties)wrywing* / F_f / f /18 N / F_w / f_w
N	F_N / Normal / *Normaal* / 169,74 N

Notes/*Aantekeninge:*
• Mark awarded for label and arrow, but penalise only once if arrows are omitted/*Punt toegeken vir benoeming en pyltjie, maar penaliseer slegs een keer indien pyle uitgelaat is.* • Do not penalise for length of arrows, drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie, die tekening is nie volgens skaal nie.* • Any other additional force(s) deduct 1 mark. / *Enige ander addisionele krag(te) trek 1 punt af.* • If force(s) do not make contact with body deduct 1 mark. /*Indien krag(te) nie met die voorwerp kontak maak nie, trek 1 punt af.*

(4)

2.3

OPTION 1/*OPSIE 1*

Positive up the incline/*Positief opwaarts teen skuinsvlak*

$F_{net} = ma$
$F + f_k + w_{||} = ma$
$F + (-f_k) + (-w_{||}) = ma$
$F - (f_k + w_{||}) = ma$
✓Any one/*Enige een*

$\underline{F - [18 + (20)(9,8)(\sin 30^o)]}$ ✓ = 0 ✓
F = 116 N ✓

NOTE/*LET WEL*
$F_{net} = 0$ ✓✓
$F = f_k + w_{||}$ ✓✓

OPTION 2/*OPSIE 2*

Positive up the incline/*Positief opwaarts teen skuinsvlak*

$W_{net} = \Delta E_k$ ✓
$F\Delta x\cos 0^o + f\Delta x\cos 180^o + w\Delta x\cos 120^o$ ✓= 0 ✓
$F\Delta x = 18\Delta x + (20)(9,8)\Delta x(0,5)$
F = 116 N ✓

NOTE/*LET WEL*
$W_{net} = 0$ ✓✓
$F\Delta x = f\Delta x + w\Delta x(0,5)$ ✓✓

(4)

2.4 **POSITIVE MARKING FROM QUESTION 2.3 /**
POSITIEWE NASIEN VANAF VRAAG 2.3

116 N / f + $w_{||}$ ✓ Down the incline/opposite to direction of motion /*Teen die helling af* / *in teenoorgestelde rigting van beweging*✓

ACCEPT/*AANVAAR*:
Downwards/down/*Afwaarts/af*

(2)

2.5 **POSITIVE MARKING FROM QUESTION 2.4 /**
POSITIEWE NASIEN VANAF VRAAG 2.4

OPTION 1/*OPSIE 1*

Up the incline positive/*Teen skuinsvlak op positief*

$F_{net} = ma$
$\underline{-116 = 20a}$ ✓
$a = -5,80\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓ $\underline{0 = (2)^2 + (2)(-5,8)\Delta x}$✓ $\Delta x = 0,34$ m ✓	$v_f = v_i + \Delta t$ $0 = 2 + (-5,8)\Delta t$ $\Delta t = 0,34$ s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ $(-116)\Delta t = (20)(0 - 2)$ $\Delta t = 0,34$ s $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $=\underline{(2)(0,34) + \frac{1}{2}(-5,8)(0,34)^2}$✓ $= 0,34$ m ✓	$v_f = v_i + \Delta t$ $0 = 2 + (-5,8)\Delta t$ $\Delta t = 0,34$ s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ $(-116)\Delta t = (20)(0 - 2)$ $\Delta t = 0,34$ s $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{2 + 0}{2}\right)0,34$ ✓ $= 0,34$ m ✓

OPTION 1/*OPSIE 1*
Down the incline positive /*Teen skuinsvlak af positief*

$F_{net} = ma$
$116 = 20a$ ✓
$a = 5{,}80\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓ $0 = (-2)^2 + (2)(5{,}8)\Delta x$ ✓ $\Delta x = -0{,}34$ m Distance = 0,34 m ✓ *Afstand*	$v_f = v_i + a\Delta t$ $0 = -2 + (5{,}8)\Delta t$ $\Delta t = 0{,}34$ s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ $(116)\Delta t = (20)(0 - (-2))$ $\Delta t = 0{,}34$ s $\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $= (-2)(0{,}34) + \frac{1}{2}(5{,}8)(0{,}34)^2$ ✓ $= -0{,}34$ m ✓ Distance/*Afstand* = 0,34 m ✓	$v_f = v_i + a\Delta t$ $0 = -2 + (5{,}8)\Delta t$ $\Delta t = 0{,}34$ s **OR/*OF*** $F_{net}\Delta t = m(v_f - v_i)$ $(116)\Delta t = (20)(0-(-2))$ $\Delta t = 0{,}34$ s $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{-2 + 0}{2}\right)0{,}34$ ✓ $= -0{,}34$ m ✓ Distance/*Afstand* = 0,34 m ✓

OPTION 2/*OPSIE 2*
$W_{net} = \Delta E_K$
$F_{net}\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$(116)\Delta x\cos 180^o$ ✓$= \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$\Delta x = 0{,}34$ m ✓

OPTION 3/*OPSIE 3*
$W_{net} = \Delta E_K$
$W_f + W_{wll} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$f\Delta x\cos\theta + (mg\sin 30^o)\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$(18)\Delta x\cos 180^o + (20)(9{,}8)\sin 30^o\Delta x\cos 180^o$ ✓$= \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$\Delta x = 0{,}34$ m ✓

OPTION 4/*OPSIE 4*
$W_{net} = \Delta E_K$
$W_f + W_w = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$f\Delta x\cos\theta + mg\Delta x\cos 120° = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$(18)\Delta x\cos 180^o + (20)(9{,}8)\Delta x\cos 120^o$ ✓$= \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$\Delta x = 0{,}34$ m ✓

OPTION 5/*OPSIE 5*
$W_{nc} = \Delta E_p + \Delta E_k$
$f\Delta x\cos\theta = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$18\Delta x\cos 180^o$ ✓ $= 20(9{,}8)\Delta x + \frac{1}{2}(20)(0^2 - 2^2)$ ✓
$-18\Delta x = 196\Delta x\sin 30^o - 40$
$\Delta x = 0{,}34$ m ✓

(4)
[16]

QUESTION 3/*VRAAG 3*

3.1 No/*Nee* ✓

ANY ONE/*ENIGE EEN*:

- Gravitational force is not the only force acting on the balloon. /There are other forces acting on the balloon. ✓
  Gravitasiekrag is nie die enigste krag wat op die ballon inwerk nie./Daar is ander kragte wat op die ballon inwerk.
- Its acceleration is not 9,8 $m \cdot s^{-2}$/is zero.
  Sy versnelling is nie 9,8 $m \cdot s^{-2}$/is nul.
- It has constant velocity/no acceleration.
  Dit het 'n konstante snelheid/geen versnelling nie. (2)

3.2.1

OPTION 1/*OPSIE 1*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{(-62,68)^2 = v_i^2 + 2(-9,8)(-200)}$ ✓	$\underline{(62,68)^2 = v_i^2 + 2(9,8)(200)}$ ✓
$v_i = 2,96\ m \cdot s^{-1}$ ✓	$v_i = -2,96\ m \cdot s^{-1}$ $= 2,96\ m \cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$(E_{mech/meg})_{200\ m} = (E_{mech/meg})_{bottom/onder}$
$(E_P + E_K)_{200\ m} = (E_P + E_K)_{bottom/onder}$
$(mgh + ½\ mv^2)_{200\ m} = (mgh + ½\ mv^2)_{bottom/onder}$
✓Any one/*Enige een*

$\underline{m(9,8)(200) + ½m(v^2) = 0 + ½m(62,68)^2}$ ✓
$v_i = 2,96\ m \cdot s^{-1}$ ✓

NOTE/*LET WEL*
Mass may be omitted during substitution.
Massa mag uitgelaat word tydens vervanging.

OPTION 3/*OPSIE 3*

$W_{nc} = \Delta E_p + \Delta E_k$
$0 = mg(h_f - h_i) + ½m(v_f^2 - v_i^2)$
✓Any one/*Enige een*

$\underline{0 = m(9,8)(0 - 200) + ½m(62,68^2 - v_i^2)}$ ✓
$v_i = 2,96\ m \cdot s^{-1}$ ✓

NOTE/*LET WEL*
Mass may be omitted during substitution.
Massa mag uitgelaat word tydens vervanging.

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$
$mg\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$
✓Any one/*Enige een*

$\underline{m(9,8)(200) = + ½m(62,68^2 - v_i^2)}$ ✓
$v_i = 2,96\ m \cdot s^{-1}$ ✓

NOTE/*LET WEL*
Mass may be omitted during substitution.
Massa mag uitgelaat word tydens vervanging. (3)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1/**
POSITIEWE NASIEN VANAF VRAAG 3.2.1

Marking criteria/*Nasienkriteria*
- Formula to calculate Δt of stone **A** ✓
  *Formule om Δt van klip **A** te bereken*
- Substitution to calculate Δt of stone **A** ✓
  *Vervanging om Δt van klip **A** te bereken*
- Final answer/*Finale antwoord*: 6,70 s ✓ **Accept/*Aanvaar:*** (6,69 to/*tot* 6,7)

NOTE: The calculation of Δt for **A** might be split up into two parts.
***LET WEL*:** *Die berekening van Δt vir **A** kan in twee dele opgedeel word.*

OPTION 1/*OPSIE 1*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$-62,68 = 2,96 + (-9,8)\Delta t$ ✓	$62,68 = -2,96 + 9,8\Delta t$ ✓
$\Delta t = 6,70$ s ✓ (6,698)	$\Delta t = 6,70$ s ✓ (6,698)
OPTION 2/*OPSIE 2*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$-200 = (2,96)\Delta t + ½ (-9,8)\Delta t^2$ ✓	$200 = (-2,96)\ \Delta t + ½ (9,8)\Delta t^2$ ✓
$\Delta t = 6,70$ s ✓ (6,697)	$\Delta t = 6,70$ s ✓ (6,697)
OPTION 3/*OPSIE 3*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-200 = \left(\frac{+2,96 + (-62,68)}{2}\right)\Delta t$ ✓	$200 = \left(\frac{-2,96 + 62,68}{2}\right)\Delta t$ ✓
$\Delta t = 6,70$ s ✓ (6,698)	$\Delta t = 6,70$ s ✓ (6,698)
OPTION 4/*OPSIE 4*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
From 200 m upwards:	From 200 m upwards:
Vanaf 200 m opwaarts:	*Vanaf 200 m opwaarts*:
$v_f = v_i + a\Delta t$ ✓	$v = v_i + a\Delta t$ ✓
$0 = 2,96 + (-9,8)\Delta t$ ✓	$0 = -2,96 + (9,8)\Delta t$ ✓
$\Delta t = 0,3$ s (0,302)	$\Delta t = 0,3$ s (0,302)
From max h downwards:	From max h downwards:
Vanaf maks h afwaarts:	*Vanaf maks h afwaarts*:
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$-62,68 = 0 + (-9,8)\Delta t$	$62,68 = 0 + (9,8)\Delta t$
$\Delta t = 6,40$ s (6,369)	$\Delta t = 6,40$ s (6,369)
$t_A = 0,3 + 6,40 = 6,7$ s ✓	$t_A = 0,3 + 6,40 = 6,7$ s ✓

OPTION 5/*OPSIE 5*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
From 200 m upwards: *Vanaf 200 m opwaarts:* $v_f = v_i + a\Delta t$ ✓ $0 = 2{,}96 + (-9{,}8)\Delta t$ ✓ $\Delta t = 0{,}3$ s (0,302)	From 200 m upwards: *Vanaf 200 m opwaarts:* $v_f = v_i + a\Delta t$ ✓ $0 = -2{,}96 + (9{,}8)\Delta t$ ✓ $\Delta t = 0{,}3$ s (0,302)
From 200 m downwards: *Vanaf 200 m afwaarts:* $v_f = v_i + a\Delta t$ $-62{,}68 = -2{,}96 + (-9{,}8)\Delta t$ $\Delta t = 6{,}09$ s (6,094) $t_A = 2(0{,}3) + 6{,}09 = 6{,}69$ s ✓	From 200 m downwards: *Vanaf 200 m afwaarts:* $v_f = v_i + a\Delta t$ $62{,}68 = 2{,}96 + (9{,}8)\Delta t$ $\Delta t = 6{,}09$ s (6,094) $t_A = 2(0{,}3) + 6{,}09 = 6{,}69$ s ✓
OPTION 6/*OPSIE 6*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$F_{net}\Delta t = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ $g\Delta t = v_f - v_i$ $(-9{,}8)\Delta t = (-62{,}68) - (2{,}96)$ ✓ $\Delta t = 6{,}69$ s ✓	$F_{net}\Delta t = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ $g\Delta t = v_f - v_i$ $(9{,}8)\Delta t = 62{,}68 - (-2{,}96)$ ✓ $\Delta t = 6{,}69$ s ✓

(3)

3.2.3 **POSITIVE MARKING FROM QUESTION 3.2.1 and QUESTION 3.2.2/**
POSITIEWE NASIEN VANAF VRAAG 3.2.1 en VRAAG 3.2.2

Marking criteria/*Nasienkriteria*
- Formula to calculate Δy of stone **B** ✓
  Formule om Δy *van klip **B** te bereken*
- Substitution of t = 1,7 s ✓ (t_A – 5)
  Vervanging van t = 1,7 s (t_A – 5)
- Substitution to calculate Δy of stone **B** ✓
  *Vervanging om Δy van klip **B** te bereken*
- Substitution to calculate Δy of balloon ✓
  Vervanging om Δy van ballon te bereken
- Calculating distance between balloon and stone **B** ✓
  Berekening van afstand tussen ballon en klip **B**
- Final answer/*Finale antwoord*: 14,16 m ✓ (14,11 to/*tot* 14,16)

OPTION 1/*OPSIE 1*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
Stone B/*Klip B*:	**Stone B/*Klip B*:**
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $= \underline{2,96(6,7 - 5)+ \frac{1}{2}(-9,8)(6,7- 5)^2}$ ✓ = -9,13 m (-9,09 to/*tot* -9,13)	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $= \underline{-2,96(6,7 - 5) + \frac{1}{2}(9,8)(6,7 - 5)^2}$ ✓ = 9,13 m (9,09 to/tot 9,13)
Distance travelled by stone **B**: 9,13 m *Afstand afgelê deur klip **B**: 9,13 m*	Distance travelled by stone **B**: 9,13 m *Afstand afgelê deur klip **B**: 9,13 m*
Hot-air balloon/*Lugballon*	**Hot-air balloon/*Lugballon***
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ $= \underline{2,96(6,7 - 5)}$ ✓ + 0 = 5,03 m	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ $= \underline{-2,96(6,7 - 5)}$ ✓ + 0 = -5,03 m
Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon:* 5,03 m	Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon:* 5,03 m
Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B*** = $\underline{9,13 + 5,03}$ ✓ = 14,16 m ✓ (14,11 - 14,16)	Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B*** = $\underline{9,13 + 5,03}$ ✓ = 14,16 m ✓ (14,11 - 14,16)

OPTION 2/*OPSIE 2*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
Stone B/*Klip B*:	**Stone B/*Klip B*:**
$v_f = v_i + a\Delta t$ $= 2,96 + (-9,8)(6,70 \overset{\checkmark}{-} 5)$ $= - 13,7\ m\cdot s^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-13,7)^2 = (2,96)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = -9,13$ m Distance travelled by stone **B:** 9,13 m *Afstand afgelê deur klip **B:** 9,13 m*	$v_f = v_i + a\Delta t$ $= -2,96 + (9,8)(6,70 \overset{\checkmark}{-} 5)$ $= 13,7\ m\cdot s^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(13,7)^2 = (-2,96)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = 9,13$ m Distance travelled by stone **B:** 9,13 m *Afstand afgelê deur klip **B:** 9,13 m*
Hot-air balloon/*Lugballon*	**Hot-air balloon/*Lugballon***
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ $= -2,96(6,70 - 5) + 0$ ✓ $= -5,03$ m Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon*: 5,03 m	$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ $= -2,96(6,70 - 5) + 0$ ✓ $= -5,03$ m Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon:* 5,03 m
Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = 9,13+ 5,03 ✓ = 14,16 m ✓ (14,11 - 14,16)	Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = 9,13+ 5,03 ✓ = 14,16 m ✓ (14,11 - 14,16)
OPTION 3/*OPSIE 3*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
Stone B/*Klip B*:	**Stone B/*Klip B*:**
$v_f = v_i + a\Delta t$ $= 2,96 + (-9,8)(6,70 \overset{\checkmark}{-} 5)$ $= - 13,7\ m\cdot s^{-1}$ $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{+2,96 + (-13,7)}{2}\right)(6,70 - 5)$ ✓ $= -9,13$ m Distance travelled by stone **B:** 9,13 m *Afstand afgelê deur klip **B:** 9,13 m*	$v_f = v_i + a\Delta t$ $= -2,96 + (9,8)(6,70 \overset{\checkmark}{-} 5)$ $= 13,7\ m\cdot s^{-1}$ $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{-2,96 + (13,7)}{2}\right)(6,70 - 5)$ ✓ $= 9,13$ m Distance travelled by stone **B:** 9,13 m *Afstand afgelê deur klip **B:** 9,13 m*
Hot-air balloon/*Lugballon*	**Hot-air balloon/*Lugballon***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= 2,96(6,70 - 5) + 0$ ✓ $= 5,03$ m Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon:* 5,03 m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= -2,96(6,70 - 5) + 0$ ✓ $= -5,03$ m Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon:* 5,03 m
Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = 9,13 + 5,03 ✓ = 14,16 m ✓ (14,11 - 14,16)	Distance between hot-air balloon and stone **B**/*Afstand afgelê deur lugballon en klip **B*** = 9,13+ 5,03 ✓ = 14,16 m ✓ (14,11 - 14,16)

OPTION 4/*OPSIE 4*	
UPWARDS POSITIVE/ *OPWAARTS POSITIEF*:	**DOWNWARDS POSITIVE/ *AFWAARTS POSITIEF:***
Stone B/*Klip B*:	**Stone B/*Klip B*:**
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$= 2,96 + (-9,8)(6,70 - 5)$ ✓	$= -2,96 + (9,8)(6,70 - 5)$ ✓
$= -13,7\ m\cdot s^{-1}$	$= 13,7\ m\cdot s^{-1}$
Balloon's height after 5 s: 214,8 m	Balloon's height after 5 s: 214,8 m
Ballon se hoogte na 5 s: 214,8 m	*Ballon se hoogte na 5 s: 214,8 m*
$E_{mech/meg)214,8\ m} = (E_{mech/meg)1,7\ s}$	$(E_{mech/meg)214,8\ m} = (E_{mech/meg)1,7\ s}$
$(E_P + E_K)_{214,8\ m} = (E_P + E_K)_{1,7\ s}$ ✓	$(E_P + E_K)_{214,8\ m} = (E_P + E_K)_{1,7\ s}$ ✓
$(mgh + ½\ mv^2) = (mgh + ½\ mv^2)_{1,7s}$	$(mgh + ½\ mv^2) = (mgh + ½\ mv^2)_{1,7s}$
$\underline{(9,8)(214,9) + ½(2,96)^2} = \underline{(9,8)h + ½(13,7)^2}$ ✓	$\underline{(9,8)(214,8) + ½(2,96)^2} = \underline{(9,8)h + ½(13,7)^2}$ ✓
$\therefore h = 205,67\ m$	$\therefore h = 205,67\ m$
Distance travelled by stone **B/** *Afstand afgelê deur klip **B**:* 214,8 – 205,67 = 9,13 m	Distance travelled by stone **B/** *Afstand afgelê deur klip **B**:* 214,8 – 205,67 = 9,13 m
Hot-air balloon/*Lugballon*	**Hot-air balloon/*Lugballon***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{2,96(6,70 - 5)}$ ✓ + 0	$= \underline{-2,96(6,70 - 5)}$ ✓ + 0
$= 5,03\ m$	$= -5,03\ m$
Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon:* 5,03 m	Distance travelled by hot-air balloon/ *Afstand afgelê deur lugballon:* 5,03 m
Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B***: $\underline{9,13 + 5,03}$ ✓ = 14,16 m ✓ (14,11 to/*tot* 14,16)	Distance between hot-air balloon and stone **B**/*Afstand tussen lugballon en klip **B***: 9,13 + 5,03 ✓ = 14,16 m ✓ (14,11 to/*tot* 14,16)

<table>
<tr>
<td><u>OPTION 5/OPSIE 5</u>
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
<u>Stone B/Klip B:</u>
$v_f = v_i + a\Delta t$
$= 2,96 + (-9,8)(6,70 \overset{\checkmark}{-} 5)$
$= - 13,7\ m\cdot s^{-1}$
$W_{net} = \Delta E_K$ ✓
$F_{net}\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$
$= ½m(v_f^2 - v_i^2)$
$(9,8)\Delta h\cos 0° = \underline{½(13,7^2 – 2,96^2)}$ ✓
$\Delta h = 9,13$ m

Distance travelled by stone B/
Afstand afgelê deur klip B: 9,13 m

<u>Hot-air balloon/Lugballon</u>
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{2,96(6,70 - 5)}$ ✓ + 0
$= 5,03$ m
Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone B/Afstand tussen lugballon en klip B: $\underline{9,13 + 5,03}$ ✓ = 14,16 m ✓
(14,11 to/tot 14,16)</td>
<td><u>DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF</u>
<u>Stone B/Klip B</u>:
$v_f = v_i + a\Delta t$
$= -2,96 + (9,8)(6,70 \overset{\checkmark}{-} 5)$
$= 13,7\ m\cdot s^{-1}$
$W_{net} = \Delta E_K$ ✓
$F_{net}\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$
$= ½m(v_f^2 - v_i^2)$
$(9,8)\Delta h\cos 0° = \underline{½(13,7^2 – 2,96^2)}$ ✓
$\Delta h = 9,13$ m

Distance travelled by stone B/
Afstand afgelê deur klip B: 9,13 m

<u>Hot-air balloon/Lugballon</u>
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{-2,96(6,70 - 5)}$ ✓ + 0
$= -5,03$ m
Distance travelled by hot-air balloon/
Afstand afgelê deur lugballon: 5,03 m

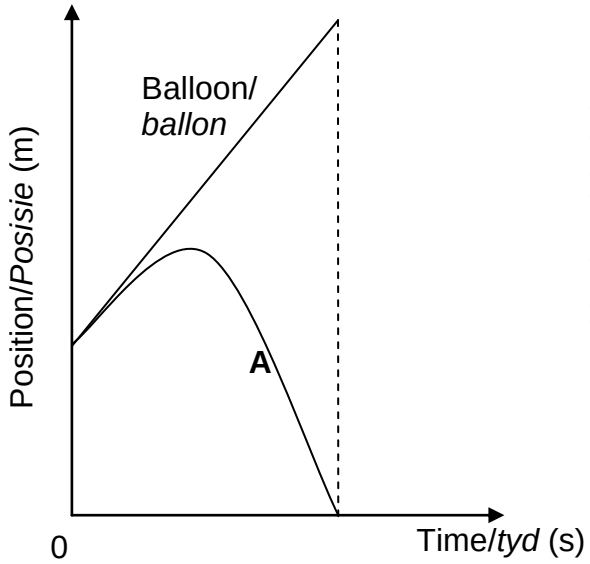
Distance between hot-air balloon and stone B/Afstand tussen lugballon en klip B: 9,13+ 5,03 ✓ = 14,16 m ✓
(14,11 to/tot 14,16)</td>
</tr>
<tr>
<td colspan="2"><u>OPTION 6/OPSIE 6</u>
Using relative velocities/Deur relatiewe snelhede te gebruik:</td>
</tr>
<tr>
<td>UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (\overset{\checkmark}{2,96} - \overset{\checkmark}{2,96})(1,7) + \frac{1}{2}(-9,8)(\overset{\checkmark}{1,7})^2$
$= -14,16$ m
Distance between hot-air balloon and stone B/Afstand tussen lugballon en klip B: 14,16 m ✓</td>
<td>DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (\overset{\checkmark}{2,96} - \overset{\checkmark}{2,96})(1,7) + \frac{1}{2}(9,8)(\overset{\checkmark}{1,7})^2$
$= 14,16$ m ✓</td>
</tr>
</table>

OPTION 7/*OPSIE 7*
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{(2,96)(1,7) + \frac{1}{2}(-9,8)(1,7)^2}$ ✓ ✓
$= -9,13$ m
Distance travelled by stone **B:** 9,13 m
*Afstand afgelê deur klip **B:** 9,13 m*

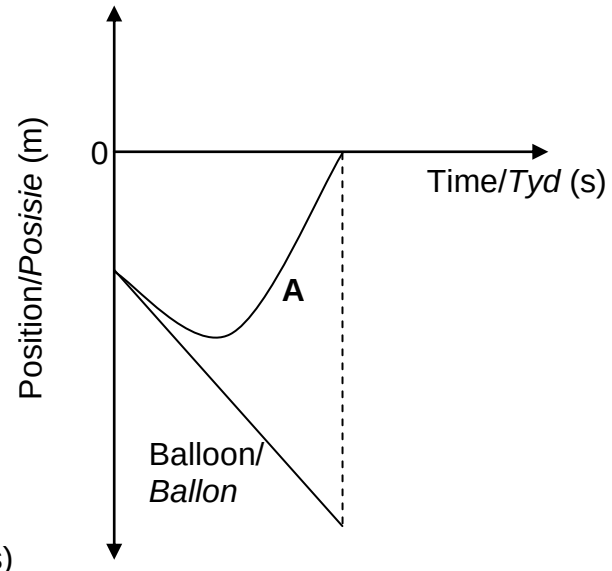
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{(-2,96)(1,7) + \frac{1}{2}(9,8)(1,7)^2}$ ✓ ✓
$= 9,13$ m

Height of stone B from the ground = 200 + 14,8 – 9,13 = 205,63 m
Hoogte van klip B vanaf die grond:
Height of balloon from the ground = 200 + (6,7)(2,96)✓ = 219,83 m
Hoogte van ballon vanaf die grond:
Distance between B and the balloon = 219,83 – 205,63 ✓ = 14,16 m✓
Afstand tussen B en die ballon: (6)

3.3 **UPWARDS POSITIVE**
OPWAARTS POSITIEF



DOWNWARDS POSITIVE
AFWAARTS POSITIEF



Criteria for graph/*Kriteria vir grafiek*	
Correct shape for stone **A** not starting from 0 m./*Korrekte vorm vir klip **A** wat nie by 0 m begin nie.*	✓
Correct shape and initial position for hot-air balloon. /*Korrekte vorm en aanvanklike posisie vir lugballon.*	✓
Gradient for hot-air balloon is higher than that of stone **A** until stone **A** reaches the maximum height./*Gradiënt vir lugballon is groter as dié vir klip **A** totdat klip **A** sy maksimum hoogte bereik.*	✓
Both graphs starting at the same position and ending at the same time. / *Beide grafieke begin by dieselfde posisie en eindig by dieselfde tyd*.	✓

(4)
[18]

QUESTION 4/*VRAAG 4*

4.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. /*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*
NOTE/*LET WEL*
If "total" is omitted: minus 1 mark / *Indien "totaal" uitgelaat is: minus 1 punt*

A collision in which both the total momentum and <u>total</u> <u>kinetic energy</u> are <u>conserved</u>.✓✓
'n Botsing waar die totale momentum en die <u>totale</u> <u>kinetiese energie</u> <u>behoue bly.</u> (2)

4.2

<u>OPTION 1/*OPSIE 1*</u>

$\sum E_{Ki} = \sum E_{Kf}$
$\frac{1}{2}m_1v_{i1}^2 + \frac{1}{2}m_2v_{i2}^2 = \frac{1}{2}m_1v_{f1}^2 + \frac{1}{2}m_2v_{f2}^2$
$\frac{1}{2}m_xv_{ix}^2 + \frac{1}{2}m_yv_{iy}^2 = \frac{1}{2}m_xv_{fx}^2 + \frac{1}{2}m_yv_{fy}^2$
✓Any one/*Enige een*

$\underline{\frac{1}{2}(10)(2)^2 + \frac{1}{2}(2)v_{iy}^2}$ ✓ = <u>0 + 36</u> ✓
$v_y = \pm 4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes* ✓ **ACCEPT/*AANVAAR:*** left/*links*

<u>OPTION 2/*OPSIE 2*</u>

$E_{Ki} = \frac{1}{2}\ m_Yv_f^2$
$36 = \frac{1}{2}\ (2)\ v_f^2$
$v_f = 6\ m\cdot s^{-1}$

$\sum p_i = \sum p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$m_xv_{xi} + m_yv_{yi} = m_Xv_{xf} + m_yv_{yf}$
✓Any one/*Enige een*

$\underline{(10)(2) + (2)v_y}$ ✓ = 0 + (2)(6) ✓
$v_y = -4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes*✓ **ACCEPT/*AANVAAR***: left/*links*

<u>OPTION 3/*OPSIE 3*</u>

$E_{Ki} = \frac{1}{2}\ m_Yv_f^2$
$36 = \frac{1}{2}\ (2)\ v_f^2$
$v_f = 6\ m\cdot s^{-1}$

$\Delta p_X = -\Delta p_Y$
$m_x(v_{Xf} - v_{Xi}) = -\ m_Y(v_{Yf} - v_{Yi})$
✓Any one/*Enige een*

$(10)(0 - 2)$✓ = -(2)(6 – v_Y) ✓
$v_{Yf} = -4\ m\cdot s^{-1}$
$v_y = 4\ m\cdot s^{-1}$ ✓ west/*wes*✓ **ACCEPT/*AANVAAR:*** left/*links* (5)

4.3 **POSITIVE MARKING FROM QUESTION 4.2 FOR Y; OPTIONS 1, 3 and 6**
POSITIEWE NASIEN VANAF VRAAG 4.2 VIR Y; OPSIES 1, 3 en 6

<table>
<tr>
<td><u>OPTION 1/OPSIE 1</u>
EAST POSITIVE/OOS POSITIEF:
For Y/Vir Y:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } Enige een
$\underline{F_{net}\ (0,1) = 2\{6 - (-4)\}}$ ✓
$F_{net} = 200$ N ✓</td>
<td>WEST POSITIVE/WES POSITIEF:
For Y/Vir Y:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } Enige een
$\underline{F_{net}\ (0,1) = 2(-6 - 4)}$ ✓
$F_{net} = -200$ N
$F_{net} = 200$ N ✓</td>
</tr>
<tr>
<td><u>OPTION 2/OPSIE 2</u>
EAST POSITIVE/OOS POSITIEF:
For X/Vir X:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } Enige een
$\underline{F_{net}\ (0,1) = 10(0 - 2)}$ ✓
$F_{net} = -200$ N
$F_{net} = 200$ N ✓</td>
<td>WEST POSITIVE/WES POSITIEF
For X/Vir X:
$F_{net}\Delta t = \Delta p$ } ✓Any one/
$F_{net}\Delta t = m(v_f - v_i)$ } Enige een
$\underline{F_{net}\ (0,1) = 10\{0 - (-2)\}}$ ✓
$F_{net} = 200$ N ✓</td>
</tr>
<tr>
<td><u>OPTION 3/OPSIE 3</u>
EAST POSITIVE/OOS POSITIEF:
For Y/Vir Y:
$v_f = v_i + a\Delta t$
$6 = -4 + a(0,1)$
$a = 100\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$= \underline{2(100)}$ ✓
$= 200$ N ✓</td>
<td>WEST POSITIVE/WES POSITIEF
For Y/Vir Y:
$v_f = v_i + a\Delta t$
$-6 = 4 + a(0,1)$
$a = -100\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$= \underline{2(-100)}$ ✓
$= -200$ N
$F_{net} = 200$ N ✓</td>
</tr>
<tr>
<td><u>OPTION 4/OPSIE 4</u>
EAST POSITIVE/OOS POSITIEF:
For X/Vir X:
$v_f = v_i + a\Delta t$
$0 = 2 + a(0,1)$
$a = -20\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$= \underline{10(-20)}$ ✓
$= -200$ N
$F_{net} = 200$ N ✓</td>
<td>WEST POSITIVE/WES POSITIEF
For X/Vir X:
$v_f = v_i + a\Delta t$
$0 = -2 + a(0,1)$
$a = 20\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$= \underline{10(20)}$ ✓
$F_{net} = 200$ N ✓</td>
</tr>
<tr>
<td colspan="2"><u>OPTION 5/OPSIE 5</u>
EAST POSITIVE/OOS POSITIEF:
For X/Vir X:
$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$0 = 2 + a(0,1)$ $\quad 0 = (2)^2 + 2(-20)\Delta x$ $\quad = \left(\frac{0+2}{2}\right)(0,1)$
$a = -20\ m\cdot s^{-2}$ $\quad \Delta x = 0,10$ m $\quad = 0,10$ m
$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$\underline{F_{net}(0,1)\cos 180^o = ½\ (10)(0^2 - 2^2)}$ ✓
$F_{net} = 200$ N ✓</td>
</tr>
</table>

OPTION 5/*OPSIE 5*
WEST POSITIVE/*WES POSITIEF*:
For **X**/*Vir **X**:*

$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$0 = -2 + a(0,1)$ $\quad 0 = (-2)^2 + 2(20)\Delta x$ $\quad = \left(\frac{0+(-2)}{2}\right)(0,1)$

$a = 20\ m\cdot s^{-2}$ $\quad \Delta x = -0,10\ m$ $\quad = -0,10\ m$

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos180^o = ½\ (10)(0^2 - 2^2)$ ✓
$F_{net} = 200\ N$ ✓

OPTION 6/*OPSIE 6*
EAST POSITIVE/*OOS POSITIEF*:
For **Y**/*Vir **Y**:*

$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$6 = -4 + a(0,1)$ $\quad (6)^2 = (-4)^2 + 2(100)\Delta x$ $\quad = \left(\frac{6-4}{2}\right)(0,1)$

$a = 100\ m\cdot s^{-2}$ $\quad \Delta x = 0,10\ m$ $\quad = 0,10\ m$

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos0° = ½\ (2)(6^2 - (-4)^2)$ ✓
$F_{net} = 200\ N$ ✓

OPTION 6/*OPSIE 6*
WEST POSITIVE/*WES POSITIEF*:
For **Y**/*Vir **Y**:*

$v_f = v_i + a\Delta t$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$-6 = 4 + a(0,1)$ $\quad (-6)^2 = (4)^2 + 2(-100)\Delta x$ $\quad = \left(\frac{-6+4}{2}\right)(0,1)$

$a = -100\ m\cdot s^{-2}$ $\quad \Delta x = -0,10\ m$ $\quad = -0,10\ m$

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$
$F_{net}(0,1)\cos0° = ½\ (2)((-6)^2 - (4)^2)$ ✓
$F_{net} = 200\ N$ ✓

(3)
[10]

QUESTION 5/*VRAAG 5*

5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. /*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

ACCEPT/*AANVAAR*
For isolated system:
- Closed system/*Geslote sisteem.*
- Only conservative forces act on the system/*Slegs konserwatiewe kragte werk in op die sisteem.*
- No external forces act on system/*Geen eksterne kragte werk in op die sisteem.*

The total mechanical energy in an isolated system remains constant / the same. ✓✓
Die totale meganiese energie in 'n geïsoleerde sisteem bly konstant / dieselfde.
OR/*OF*
The sum of the kinetic and gravitational potential energies in an isolated system remains constant/the same.
Die som van die kinetiese en gravitasie potensiële energie in 'n geïsoleerde/geslote sisteem bly konstant/dieselfde. (2)

5.2

NOTE/LET WEL
- Mass may be omitted during substitution. /*Massa mag uitgelaat word tydens vervanging.*
- If equations of motion are used. Max 1/3 for correct answer. / *Indien bewegingsvergelykings gebruik word. Maks 1/3 vir korrekte antwoord.*

OPTION 1/*OPSIE1*
$E_{P/mech\ top/meg\ bo} = E_{Q/mech\ ground\ /meg\ grond}$
$(E_p + E_k)_{P/top/bo} = (E_p + E_k)_{Q/bottom/onder}$
$(mgh + ½mv^2)_{P/top/bo} = (mgh + ½mv^2)_{Q/bottom/onder}$
✓Any one/*Enige een*
$\underline{(2)(9,8)(5) + 0 = 0 + ½(2)v_f^2}$ ✓
$v_f = 9,90\ m\cdot s^{-1}$ ✓ (9,899)

OPTION 2/*OPSIE2*
$\Delta E_p + \Delta E_K = 0$
$(mgh_f - mgh_i) + ½m(v_f^2 - v_i^2) = 0$
✓Any one/*Enige een*
$\underline{0 - (2)(9,8)(5) + ½(2)(v_f^2 - 0)}$ ✓ = 0
$v_f = 9,90\ m\cdot s^{-1}$ ✓ (9,899) (3)

5.3 **POSITIVE MARKING FROM QUESTION 5.2.**
***POSITIEWE NASIEN VANAF VRAAG 5.2*.**

OPTION 1/*OPSIE 1*
$W_{net} = \Delta E_K$
$W_f = ½mv_f^2 - ½mv_i^2$
$W_N + W_f + W_w = ½mv_f^2 - ½mv_i^2$
$f\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$
✓Any one/*Enige een*
$\underline{f(10)\cos 180°}$ ✓= $\underline{½(2)(4^2 - 9,90^2)}$ ✓
f = 8,2 N ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_K + \Delta E_p$
$W_f = ½mv_f^2 - ½mv_i^2$
$W_N + W_f = ½mv_f^2 - ½mv_i^2$
$f\Delta x\cos\theta = ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓Any one/*Enige een*
$f(10)\cos180°$ ✓$= ½(2)(4^2 - 9{,}90^2) + 0$ ✓
$f = 8{,}2$ N ✓ (4)

5.4

LEFT NEGATIVE/*LINKS NEGATIEF*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$
$F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/*Enige een*
$-14 = 2(v_f - 4)$ ✓
$v_f = -3\ m\cdot s^{-1}$

ACCEPT/*AANVAAR*
Impulse/*Impuls* = mΔv

$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(-3)^2 - 4^2]$ ✓
$= -7$ J ✓

Do not penalise if +3 is substituted.
Moenie penaliseer indien +3 vervang is.

ACCEPT/AANVAAR

$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(0)^2 - (-3)^2]$ ✓
$= -9$ J ✓

Do not penalise if +3 is substituted.
Moenie penaliseer indien +3 vervang is.

RIGHT NEGATIVE/*REGS NEGATIEF*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$
$F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/*Enige een*
$14 = 2(v_f - (-4))$ ✓
$v_f = 3\ m\cdot s^{-1}$

ACCEPT/*AANVAAR*
Impulse/*Impuls* = mΔv

$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(3)^2 - (-4)^2]$ ✓
$= -7$ J ✓

Do not penalise if +4 is substituted.
Moenie penaliseer indien +4 vervang is.

ACCEPT/*AANVAAR*

$\Delta E_K = ½mv_f^2 - ½mv_i^2$ ✓
$= ½(2)[(0)^2 - (-3)^2]$ ✓
$= -9$ J ✓

Do not penalise if +3 is substituted.
Moenie penaliseer indien +3 vervang is.

(5)
[14]

QUESTION 6/*VRAAG 6*

6.1 $v = f\lambda$ ✓
$340 = 680\lambda$ ✓
$\lambda = 0,5$ m ✓ (3)

6.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The change in frequency/pitch/wavelength of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓
Die verandering in frekwensie/toonhoogte/golflengte van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting het.

OR/*OF*

An (apparent) change in observed/detected frequency/pitch/wavelength, as a result of the relative motion between a source and an observer (listener). ✓✓
'n (Skynbare) verandering in waargenome frekwensie/toonhoogte/golflengte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.3.1 Decreased/*Afgeneem* ✓ (1)

6.3.2 Increased/*Toegeneem* ✓ (1)

6.4 **POSITIVE MARKING FROM QUESTION 6.1 /**
POSITIEWE NASIEN VANAF VRAAG 6.1

OPTION 1/*OPSIE 1*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓

$f_L = \frac{v}{\lambda_L}$
$= \frac{340}{0,5 - 0,05}$ ✓
$= \frac{340}{0,45}$
$= 755,56$ Hz

$755,56 = \left(\frac{340 + 0}{340 - v_s}\right) 680$ ✓

$v_s = 34$ m·s^{-1} ✓ (33,67 - 34,04)

OPTION 2/*OPSIE 2*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓

$\frac{v}{\lambda_L} = \left(\frac{v + 0}{v - v_s}\right) f_s$

$\frac{340}{0,5 - 0,05}$ ✓ $= \left(\frac{340 + 0}{340 - v_s}\right)$ ✓ 680 ✓

$\frac{340}{0,45} = \left(\frac{340 + 0}{340 - v_s}\right) 680$

$v_s = 34$ m·s^{-1} ✓ (33,67 - 34,04)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓ $\frac{v}{\lambda_L} = \left(\frac{v+0}{v - v_s}\right)\frac{v}{\lambda_s}$ $\therefore \quad \frac{1}{\lambda_L} = \left(\frac{v+0}{v - v_s}\right)\frac{1}{\lambda_s}$ $\frac{1}{0,5-0,05}$ ✓ = $\left(\frac{340+0}{340-v_s}\right)$ ✓ $\frac{1}{0,5}$ ✓ $\frac{1}{0,45} = \left(\frac{340+0}{340-v_s}\right)\frac{1}{0,5}$ v_s = 34 m·s^{-1} ✓ (33,67 - 34,04)	$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR** $f_L = \frac{v}{v - v_s} f_s$ ✓ $v_1 = v_2$ $f_s\lambda_1 = f_L\lambda_2$ $\underline{(600)(0,5) = f_L(0,45)}$ ✓ f_L = 755,56 Hz $755,56 = \left(\frac{340+0}{340-v_s}\right)$ ✓ 680 ✓ v_s = 34 m·s^{-1} ✓ (33,67 - 34,04)

(5)
[12]

QUESTION 7/*VRAAG 7*

7.1.1 Added/*Toegevoeg* ✓ (1)

7.1.2

NOTE/*LET WEL*
Ignore signs of the charges./ *Ignoreer tekens van die ladings.*

$n = \frac{Q}{q_e}$ ✓

$= \frac{-1,95 \times 10^{-6}}{-1,6 \times 10^{-19}}$ ✓

= 1,22 x 10^{13} ✓ (1,21875 x 10^{13}) (3)

7.1.3

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The (electrostatic) force experienced per unit positive charge placed at that point.
Die (elektrostatiese) krag per eenheid positiewe lading wat by die punt geplaas is.

NOTE/*LET WEL* (1 mark for:/*1 punt vir:*)
An electric field is a region of space in which an electric charge experiences a force.
'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind. (2)

7.1.4 $E = \frac{kQ}{r^2}$ ✓

$= \frac{(9 \times 10^9)(1,95 \times 10^{-6})}{(0,5)^2}$ ✓

= 7,02 x 10^4 N·C^{-1} ✓ (3)

7.2

OPTION 1/*OPSIE 1*

Marking criteria/*Nasienkriteria:*

- Coulomb's Law formula/*Coulomb se formule* ✓
- Correct substitution for F_{q1} **OR** F_{q2} into $\frac{kQ_1Q_2}{r^2}$ ✓

  *Korrekte substitusie van F_{q1}**OF** F_{q2}* in $\frac{kQ_1Q_2}{r^2}$
- Correct substitution of 1,38 N for $F_{(net)}$ /*Korrekte substitusie van 1,38 N* vir $F_{(net)}$✓
- Subtracting (vector addition) electrostatic forces /*Aftrek (vektoraddisie) van elektrostatiese kragte* ✓
- Final answer/*Finale antwoord*: 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

$F_{E(net)} = F_{q2} + F_{q1}$

$1{,}38 \checkmark = \left(+\frac{kQ_1Q_2}{r^2}\right) + \left(-\frac{kQ_1Q_2}{r^2}\right)\checkmark$

$1{,}38 = \left(+\frac{(9\times10^9)(1{,}95\times10^{-6})q_2}{(0{,}03)^2}\right) + \left(\checkmark -\frac{(9\times10^9)(1{,}95\times10^{-6})q_2}{(0{,}05)^2}\right)\checkmark$

q_2 = 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

OPTION 2/*OPSIE 2*

Marking criteria/*Nasienkriteria*:

- $E = \frac{kQ}{r^2}$ ✓
- Correct substitution of 7,08 x 10^5 N·C^{-1}/*Korrekte substitusie van 7,08 x10^5 N·C^{-1}* ✓
- Correct substitution for E_{q1} **OR** E_{q2} into $\frac{kQ_2}{r^2}$ ✓

  *Korrekte substitusie van E_{q1} **OF** E_{q2} in* $\frac{kQ_2}{r^2}$
- Subtracting electric fields/*Aftrek van elektriese velde* ✓
- Final answer/*Finale antwoord*: 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

$E = \frac{F}{q} = \frac{1{,}38}{1{,}95\times10^{-6}}$

= 7,08 x 10^5 N·C^{-1} (707692,30)

$E_{net} = E_{q2} + E_{q1}$

7,08 x 10^5 ✓ $= \left(+\frac{kQ_2}{r^2}\right) + \left(-\frac{kQ_1}{r^2}\right)\checkmark$

$= \left(+\frac{(9\times10^9)q_2}{(0{,}03)^2}\right) + \left(\checkmark -\frac{(9\times10^9)q_1}{(0{,}05)^2}\right)\checkmark$

q_2 = 1,11 x 10^{-7} C ✓ (1,106 x 10^{-7} C)

(5)
[14]

QUESTION 8/*VRAAG 8*

8.1.1 12 V ✓ (1)

8.1.2 0 (V) ✓ (1)

8.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The rate at which work is done or energy is expended/transferred.
Die tempo waarteen arbeid verrig word of energie oorgedra word. (2)

8.3

OPTION 1/*OPSIE 1*

$P = I^2R$ ✓
$5,76 = (1,2^2)R$ ✓
$R = 4\ \Omega$ ✓

OPTION 2/*OPSIE 2*

$P = VI$
$5,76 = V(1,2)$
$V = 4,8$ V

$P = \frac{V^2}{R}$ ✓
$5,76 = \frac{(4,8)^2}{R}$ ✓
$R = 4\ \Omega$ ✓

$V = IR$ ✓
$4,8 = (1,2)R$ ✓
$R = 4\ \Omega$ ✓

(3)

8.4 **POSITIVE MARKING FROM QUESTION 8.3**
POSITIEWE NASIEN VANAF VRAAG 8.3

OPTION 1/*OPSIE 1*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{8,4}$ ✓

$R_p = 3,5\ \Omega$

$R_T = 3,5 + 4$ ✓
$= 7,5\ \Omega$ ✓

OPTION 2/*OPSIE 2*

$R_p = \frac{R_1R_2}{R_1 + R_2}$

$R_p = \frac{(6)(8,4)}{6 + 8,4}$ ✓

$R_p = 3,5\ \Omega$

$R_T = 3,5 + 4$ ✓
$= 7,5\ \Omega$ ✓

(3)

8.5 **POSITIVE MARKING FROM QUESTION 8.3**
POSITIEWE NASIEN VANAF VRAAG 8.3

CALCULATE V_P/*BEREKEN V_P*
Marking criteria/*Nasienkriteria*
- Formula/*Formule*:
  $V = IR$ ✓
- Substitution to calculate V_p /
  Vervanging om V_p te bereken.✓

CALCULATE V_2/*BEREKEN V_2*
Marking criteria/*Nasienkriteria*
- Substitution to calculate I_{branch} or ratio of R_{branch}/*Vervanging om I_{tak} of verhouding van R_{tak} te bereken.* ✓
- Substitution to calculate V_2 /
  Vervanging om V_2 te bereken.✓
- Final Answer/*Finale antwoord:* 3 V✓

OPTION 1/*OPSIE 1*

$V_p = IR$
$= (1,2)(3,5)$ ✓
$= 4,2$ V

$I = \frac{V}{R}$
$= \frac{4,2}{8,4}$ ✓
$= 0,5$ A

$V_2 = IR$ ✓
$= (0,5)(6)$ ✓
$= 3$ V ✓

OPTION 2/*OPSIE 2*

$P_x = VI$
$5,76 = V(1,2)$
$V_x = 4,8$ V
$I_{6\,\Omega} = \frac{8,4}{14,4} \times 1,2$
$= 0,7$ A
$V_{6\,\Omega} = IR$
$= (0,7)(6)$ ✓
$= 4,2$ V

OR/*OF*

OPTION 3/*OPSIE 3*

$\varepsilon = I(R + r)$
$12 = 1,2(7,5 + r)$
$r = 2,5\ \Omega$
$V_p = 12 - 1,2(2,5 + 4)$ ✓$= 4,2$ V

$R_{2,4} : R_6 = 2,4 : 6$ ✓
$= 2 : 5$
$V_{2,4} : V_6 = 1,2 : 3$ ✓✓
$V_2 = 3$ V ✓

CALCULATION OF $I_{8,4\Omega}$ AND V_2/*BEREKENING VAN $I_{8,4\Omega}$ EN V_2*
OPTION 4/*OPSIE 4*

$I_{8,4\Omega} = \left(\frac{6}{14,4}\right)(1,2)$ **OR/*OF*** $\left(\frac{3,5}{8,4}\right)(1,2)$
$= 0,5$ A ✓✓
$V_2 = IR$ ✓
$= (0,5)(6)$ ✓
$= 3$ V ✓

OPTION 5/*OPSIE 5*

$V_x = IR$
$= (1,2)(4)$
$= 4,8$ V

$V_{ext} = IR_{ext}$
$= (1,2)(7,5)$
$= 9$ V

$V_p = 9 - 4,8$✓ $= 4,2$ V

$V_{8,4\Omega} = IR$
$4,2 = I(8,4)$✓
$I = 0,5$ A

$V_2 = IR$ ✓
$= (0,5)(6)$ ✓
$= 3$ V ✓

(5)

8.6 Decreases/*Neem af* ✓
Total resistance decreases. / *Totale weerstand neem af*. ✓
Current increases. /*Stroom neem toe*. ✓
$V_{internal}$ /Internal voltage ("lost volts") increases. /*Interne potensiaalverskil neem toe.* ✓
$V_{external}$ /external voltage decreases. /Eksterne potensiaalverskil neem af.

NOTE/*LET WEL*
Do not penalise if "total" is omitted. / *Moenie penaliseer indien "totaal" uitgelaat is nie.* (4)
[19]

QUESTION 9/*VRAAG 9*

9. 1 Slip rings/*Sleepringe* ✓

ACCEPT/*AANVAAR*
Split ring/slip ring commutator /*splitring*/*sleepring kommutator* (1)

9. 2 Y to/*na* X ✓✓ (2)

9.3

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The AC potential difference which dissipates the same amount of energy as an equivalent DC potential difference.
Die WS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke GS-potensiaalverskil.

ACCEPT/*AANVAAR*
The DC potential difference which dissipates the same amount of energy as an equivalent AC potential difference.
Die GS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke WS-potensiaalverskil. (2)

9.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ $= \frac{100}{\sqrt{2}}$ ✓ $= 70{,}71$ V $I_{rms/wgk} = \frac{V_{rms/wgk}}{R}$ ✓ $= \frac{70{,}71}{25}$ ✓ $= 2{,}83$ A ✓ **ACCEPT/*AANVAAR*** If subscipts omitted in V = IR *Indien onderskrifte uitgelaat is in V = IR*	$I_{max/maks} = \frac{V_{max/maks}}{R}$ $= \frac{100}{25}$ ✓ $= 4$ A $I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$ ✓ $= \frac{4}{\sqrt{2}}$ ✓ $= 2{,}83$ A ✓	$P_{ave} = \frac{V_{rms}^2}{R}$ $= \frac{\frac{100^2}{\sqrt{2}}}{25}$ ✓ $= 200$ W $P_{ave} = V_{rms}I_{rms}$ ✓ $200 = \left(\frac{100}{\sqrt{2}}\right)I_{rms}$ ✓ $I_{rms} = 2{,}83$ A ✓

(4)

9.5 **POSITIVE MARKING FROM QUESTION 9.4 /**
POSITIEWE NASIEN VANAF VRAAG 9.4

OPTION 1/*OPSIE 1*

$P_{ave/gem} = \frac{V^2_{rms/wgk}}{R}$ ✓

$= \frac{70,71^2}{25}$ ✓

= 200,00 W ✓ (200 W)

OPTION 2/*OPSIE 2*

$P_{ave} = V_{rms}I_{rms}$ ✓

= (70,71)(2,83) ✓

= 200,11 W ✓

OPTION 3/*OPSIE 3*

$P_{ave/gem} = I^2_{rms/wgk}R$ ✓

$= (2,83)^2(25)$ ✓

= 200,22 W ✓

OPTION 4/*OPSIE 4*

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$2,83 = \frac{I_{max}}{\sqrt{2}}$

$I_{max/maks}$ = 4 A

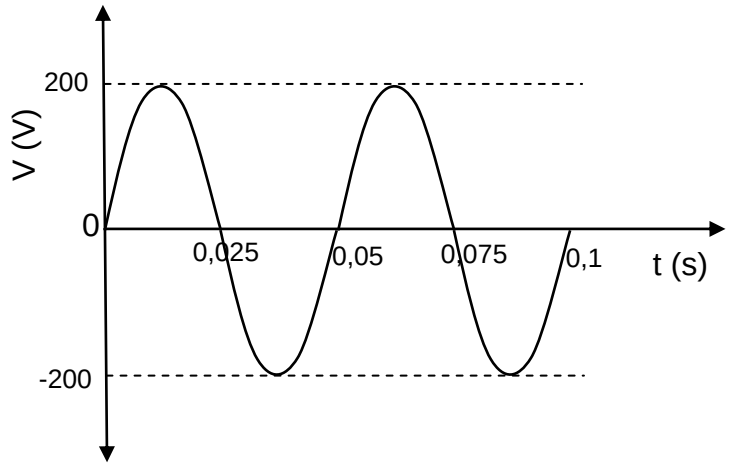
$P_{ave/gem} = \frac{V_{max/maks}I_{max/maks}}{2}$ ✓

$= \frac{(100)(4)}{2}$ ✓

= 200 W ✓

(3)

9.6



Marking criteria/*Nasienkriteria*

- 2 waves ✓
  2 golwe
- Period of wave is 0,05 s ✓
  Periode van golf is 0,05 s
- Amplitude = 200 V ✓

(3)
[15]

QUESTION 10/*VRAAG 10*

10.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The minimum frequency of light needed to eject electrons from a metal / surface. ✓✓
Minimum frekwensie van lig benodig om elektrone vanaf 'n metaal / oppervlak vry te stel. (2)

10.2 Greater than/*Groter as* ✓✓ (2)

10.3

OPTION 1/*OPSIE 1*
$E = W_o + E_{k(max)}$ ✓
$f_x = (\frac{1}{6,63 \times 10^{-34}})$ ✓$(23,01 \times 10^{-19})$ ✓ + $10,40 \times 10^{14}$ ✓
$= 4,51 \times 10^{15}$ (Hz)✓ ($45,1 \times 10^{14}$ Hz)

OPTION 2/*OPSIE 2*
$m = \frac{1}{h}$ ✓
$\frac{f_x - 10,4 \times 10^{14}}{23,01 \times 10^{-19} - 0}$ ✓ $= \frac{1}{6,63 \times 10^{-34}}$ ✓
$f_x = 4,51 \times 10^{15}$ (Hz) ✓ ($45,1 \times 10^{14}$ Hz)

OPTION 3/*OPSIE 3*
$E = W_o + E_{k(max)}$ ✓
$hf = hf_0 + E_{k(max)}$
$6,63 \times 10^{-34} f_x$ ✓$= (6,63 \times 10^{-34})(10,40 \times 10^{14})$✓$+ 23,01 \times 10^{-19}$ ✓
$f_x = 4,51 \times 10^{15}$ (Hz)✓ ($45,1 \times 10^{14}$ Hz) (5)

10.4

10.4.1 No effect/*Geen effek nie* ✓ (1)

10.4.2 Increases/*Verhoog* ✓ (1)

10.4.3 No effect/*Geen effek* nie ✓ (1)

[12]

TOTAL/*TOTAAL*: 150